



## Mikroskop Technik Rathenow



- Polarization Microscope - RMA 5 pol
- Technical Incident Light Microscope - RMA 5

User Guide



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# 1. Safety Instructions

**CAUTION!** Please read the following information carefully before using the unit and its supplementary equipment!

This unit was constructed and checked according to the safety regulations for electronic measuring devices, and was delivered securely. This User Manual contains information and warning notices that should be heeded by the user.

The unit is a light microscope, drafted according to the newest scientific and technical knowledge for the visual, micro photographic and video-technical investigation of microscopic objects. The unit should only be used for the designed purpose. All other uses (also the insertion of single components which were not designed by the manufacturer) constitute a misuse of the product. We are not liable for any damages caused by this misuse.

This unit is not meant for unattended continuous operation.

The microscope does not have any special safeguards against samples with caustic toxic, radioactive or other hazardous materials. The allowed sample amount may not be exceeded.

The unit may only be operated on the voltages indicated on the unit. Please heed the instructions in the user manual! We are not liable for any damages caused by the disregard of these instructions.

If the unit is connected to voltage, contact clamps can lead to dangerous voltages and opening the coverings or removing parts can uncover a piece under a dangerous voltage. The unit must be disconnected from power before it can be opened for adjustments, replacements, servicing or repairs.

Existing ventilation slits should not be obstructed. This also applies for ventilation slits on the bottom of the unit. No tools, loose objects or liquids should enter the unit through ventilation slits or other openings in the unit.

Only fuses with the required nominal current may be used as substitutes for the prescribed use. It is prohibited to use makeshift fuses or short-circuit the fuse support.

If safety is endangered, the unit must be removed from use and secured against unattended operation. The unit should then be sent to the production factory or a competent service technician.

Before switching on the unit, set the controller for the illumination intensity to the left catch in order to prevent blinding.

## 1.1. Characteristics and Application

The microscope RMA 5 is equipped with high quality optics, and excels due to its high optical performance.

The following additional devices are available: evaluation of investigations over Photo-/TV adapter and digital cameras, Polarization equipment, measuring software...

Different interchangeable objectives and eyepieces, which can be changed easily by a revolver (quadruple), make an extension area in an interval of 50x ... 640x possible (standard configuration).

## 1.2. Assembly and Operation RMA 5 pol

The polarization microscope RMA 5 pol comes with a fixed stand. All further components of the microscope are mounted on this stand. There is a pol.-suited binocular straight tube with wide field eyepieces (spectacles) for a research of objects.

The microscope RMA 5 pol is assembled with a revolving nosepiece (quadruple) and four M-Plan  $\infty$  objectives.. The ball bearing revolver has click stops for the positions of each objective.

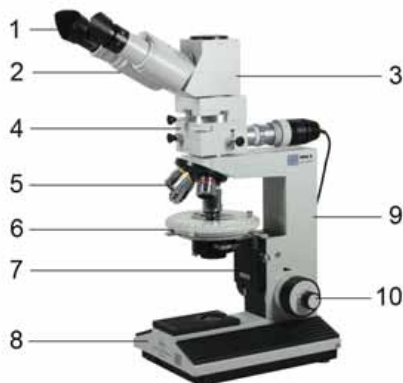
There are three stages for fixing the objects under the microscope (gliding stage, stage carrier with object guide and stage carrier with rotary stage). The objects will be illuminated by a 3W-LED incident light or transmitted light illumination (Koehler principle).

All electronic parts for the illumination are integrated into the microscope base. There is a control for adjusting the illumination in front and on the side of the microscope base. It is also possible to add other kind of illuminations to the microscope (transmitted light illumination, striped incident light).

Further information, how polarization microscopy is working, you can find in special literature.

We will describe only necessary features of the microscope RMA 5 pol at the following pages.

### *Polarization Microscope RMA 5 pol*



*pic. 1: overview RMA 5 pol*

- 1 Eyecup with eyepiece
- 2 Binocular straight tube
- 3 Angled tube / photo / TV tube 1x/0,8x
- 4 Incident light polarization tube
- 5 Revolving nosepiece with objectives
- 6 Microscope stage
- 7 Stage holder
- 8 Microscope base
- 9 Microscope stand
- 10 Coaxial coarse and fine drive adjustment

### 1.3. Technical Data RMA 5 pol

#### With Semi- Apochromat $\infty$ Objectives (standard)

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Objective (incident light) M-Plan $\infty$	5x; 10x; 20x; 50x
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Eyepiece	GF-Pw 10x/ 20
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Tube factor	1x Visuell 0,8x photo/TV
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illumination	Koehler principle with filter holder, field diaphragm and aperture diaphragm
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Total magnification $V_t = V_{obj} \times V_{eyep}$	50x ... 500x
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Object field (mm)	4,0... 0,4
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Adjustable range of coarse drive	20 mm
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Max. High of objects	35 mm
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Interpupillary adjustment	55...80 mm
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Adjustment ametropia	+/- 6 dpt
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Adjustment Object-guide	40 mm x 20 mm
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Adjustment Gliding stage	d = 40 mm
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Coaxial coarse and fine drive Resolution	2 $\mu$ m
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#### 1.4. Assembly and Operation RMA 5

The incident light microscope RMA 5 comes with a fixed stand. All further components of the microscope are mount on this stand. There is a binocular straight tube with wide field eyepieces (spectacles) for a research of objects.

The microscope RMA 5 is assembled with a revolving nosepiece (quadruple) and four M-Plan  $\infty$  objectives. Alternative you can use achromatic corrected objectives and semi plan achromatic objectives for a mechanical tube length of 160mm. The ball bearing revolver has click stops for the positions of each objective.

There are four stages for fixing the objects under the microscope (gliding stage, magnet spherical stage, stage carrier with object guide and stage carrier with rotary stage). The objects will be illuminated by a 3W-LED incident light illumination (Koehler principle).

All electronic parts for the illumination are integrated into the microscope base. There is a control for adjusting the illumination in front of the microscope base. It is also possible to add other kind of illuminations to the microscope (transmitted light illumination, striped incident light).

Further information, how a incident light microscope is working, you can find in special literature.

We will describe only necessary features of the microscope RMA 5 at the following pages.

#### *Technical – Incident Light Microscope RMA 5*



*pic.2: overview RMA 5*

- |    |  |
|----|--|
| 1  | <i>Eyecup with eyepiece</i>                              |
| 2  | <i>Binocular straight tube</i>                           |
| 3  | <i>Angled tube</i>                                       |
| 4  | <i>Incident light tube</i>                               |
| 5  | <i>Revolving nosepiece with objectives</i>               |
| 6  | <i>Microscope stage</i>                                  |
| 7  | <i>Stage holder</i>                                      |
| 8  | <i>Microscope base</i>                                   |
| 9  | <i>Microscope stand</i>                                  |
| 10 | <i>Combined Coaxial coarse and fine drive adjustment</i> |



## 1.5. Technical Data RMA 5

### Microscope: E-Plan $\infty$ Objectives

Objectives (incident light) M-Plan $\infty$	5x; 10x; 20x; 50x
Eyepiece	GF-Pw 10x/ 20
Tube	Factor 1x
Illumination	Koehler principle with filter holder, field diaphragm and aperture diaphragm
Total magnification $V_t = V_{obj} \times V_{eyep}$	50x ... 500x
Object field (mm)	4,0... 0,4
Adjustable range of coarse drive	15 mm
Max. High of objects	35 mm
Interpupillary adjustment	55...80 mm
Adjustment ametropia	+/- 6 dpt
Adjustment Object-guide	76 mm x 26 mm
Adjustment Gliding stage	d = 40 mm
Coaxial coarse and fine drive Resolution	2 $\mu$ m

### Microscope: Achromatic 160mm Objectives

Objectives	4x; 10x; 20x; 40x
Eyepiece	GF 10x/ 18
Tube	Factor 1,6x
Illumination	Koehler principle with filter holder, field diaphragm and aperture diaphragm
Total magnification $V_t = V_{obj} \times V_{eyep}$	64x... 640x
Object field (mm)	2,8... 0,28
Adjustable range of coarse drive	15 mm
Max. High of objects	35 mm
Interpupillary adjustment	55...80 mm
Adjustment ametropia	+/- 6 dpt
Adjustment Object-guide	76 mm x 26 mm
Adjustment Gliding stage	d = 40 mm
Combination drive Resolution	2,8 $\mu$ m

## 2. Starting Operations

### 2.1. Assembly

Please open carefully the packaging of the microscope.

At first the microscope stand (10) has to be taken out of the packaging and has to be put on a plan subsoil. After that the incident light tube (4) has to be set on the quick-change equipment of the microscope stand. Clamp it with the screw.

The binocular straight tube (2) and the angled tube (3) has to be taken from the packaging. Assemble the binocular straight tube into the quick-change equipment of the angled tube and clamp it with a screw.

Take this pre-assembled parts and set them to the quick-change equipment of the incident light tube and clamp it with the screw.

Now the objectives will be taken out of their protective packaging and the objectives has to be placed into the revolving nosepiece (5) in this way, that if the revolver will be rotated clockwise, the magnification will be increase.

The stage (gliding stage, stage carrier with object guide or stage carrier with rotary table) will be done into the stage holder (7) and will be clamped. The adjustment of the objectives will be done by the combined coaxial coarse and fine drive adjustment (9).

At last the eyepieces GF – Pw 10x/20 (1) will be assembled into the binocular straight tube. The eyepiece can be used with or without eyecups. The eyepiece is usable as eyepiece for spectacles. To avoid dirt within the tube, the eyepieces should be stay the whole time in the tube.

The power connection of the incident light tube can be found on the backside of the microscope base (8). The intensity of the incident light illumination can be set by the adjustment in front of the microscope base.

Further it is possible to use different filter in the filter holder of the incident light tube.

### 2.2. Adjusting the sharpness

The adjustment of the sharpness is only necessary if the binocular straight tube is in use.

The microscope can be adjusted in that kind that a sharp image is the result at all levels of magnifications.

You can achieve this in the following way:

- The distance of the eyepieces has to be adjusted by screwing up the eyepiece cone to the individual interpupillary distance.
- The left dioptre ring has to be adjusted to 0.
- Adjust a sharp picture with help of the drive mechanism (you have to look with the right eye through the right eyepiece).
- You have to adjust the sharpness on the left eye by adjusting the dioptre ring.

### 2.3. Incident light illumination

The incident light illumination tube consists a intermediate tube with a tube factor of 1x or 1,6x, an illuminating adapter and a 3W-LED illumination.

The objects will be illuminated by a 3W-LED incident light illumination (Koehler principle).

The aperture diaphragm and the field diaphragm are integrated in the illuminating adapter.

The field diaphragm is necessary to improve the contrast (by reducing the scattered light on the object layer). The biggest effect is visible at the border of the field diaphragm. In case the illumination aperture is too high, there is too much scattered light in the object field and the pictures have a low contrast. The field diaphragm is also necessary for focusing at incident light illumination.

The resolution capability, the contrast and the depth of field can be also optimised by the aperture diaphragm.

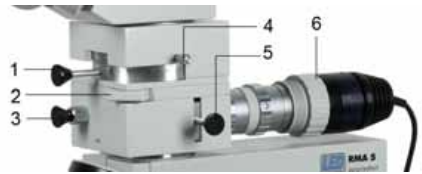


*pic.3: overview – incident light tube*

- 1 3W-LED illumination
- 2 Filter holder (opened)
- 3 Adjusting ring for the aperture stop (aperture diaphragm)
- 4 Adjusting ring for the illuminated field aperture (field diaphragm)
- 5 Intermediate tube (RMA 5 ∞)

## 2.4 Polarization units

### 2.4.1 Incident light polarization



*pic.4: overview – incident light tube*

- 1 analyzer slide
- 2 slide for compensator
- 3 slide for incident light
- 4 locking screw for analyzer
- 5 polarizer slide
- 6 incident light unit (pic. 3)

To activate the incident light push the switch on the left side of the stand and the slide for incident light (3). The polarizer slide (5) is on the right side of the tube. The 180° rotatable analyzer slide (1) is can be clamped by the locking screw (4). The incident light tube is the same as for the RMA 5 ∞.(pic.3)

### 2.4.2 Transmitted light polarization



*pic.5: overview – incident light tube*

- 1 Analyzer slide
- 2 slide for compensator
- 3 locking screw for analyzer

The polarization microscope can only be used with transmitted light. The polarizer slide is placed in the condenser of the stage or can be used as rotatable polarizer which is directly mounted into the filter holder of the transmitted light illumination of the microscope. The 180° rotatable analyzer slide (1) is clamped by the locking screw (3).

### 2.4.3 Compensator



*pic.6: compensator slide  $\lambda$  and  $\lambda/4$*

Compensator ( $\lambda$ ;  $\lambda/4$ ) filters can be used for evaluation and measurement of optical path differences and improvement or change of image contrast. The compensator have their own constant optical path difference (birefringence) and are placed in a 45° angle between the two crossed polarizers.

## 2.5. General Operating Instructions

**2.5.1.** The adjustment of the microscope in the *High positioning* can be done with the drive mechanism.

**2.5.2.** *The illumination level* can be changed by changing the adjustment in front of the microscope base or by using of different kind of filters. With help of the aperture diaphragm it is possible to change the contrast.

**2.5.3.** All tubes can be changed at the same kind. The screw under the tube has to be dissolve so that you can remove the tube. The tube has to be set into the tube mount for assembling the tube.

Don't forget to clamp the screw again. If necessary the tubes can be mount also by rotating in 180°. It isn't possible to use more than one intermediate tube at the same time.

**2.5.4.** A *change of the objectives* is for all existing objectives the same. The nosepiece has a uniform, centred and adjusted W0,8" (RMS) fine thread. Please handle all objectives with care so that it can't come off. Do not touch the objective directly with your hands. A removed objective should be placed again into the protective packaging of the objective.

**2.5.5.** All *fixed or adjustable eyepieces* from laboratory or technical microscopes can be used in the microscope RMA 5.

## 3. Maintenance and Service

The Technical Microscope RMA 5 and its supplemental equipment are service-free over a long period of time, assuming normal use. In the case of continual use (shift operation) and especially in the case of unfavourable environment conditions (dust, etc.), the unit should be serviced when needed in the following ways.

Before any servicing of the equipment, the power supply should be disconnected.

Please be carefully with all optical parts. A damage of these part will cause aberrations or not sharpen images.

All loose parts, e.g. preparations, filter or so on have to be removed from the microscope.

### 3.1. Changing the fuse

**Warning: Do not adjust inadvertently the mark of the main voltage!**

**3.1.1.** The fuse of the microscope *RMA 5* is located in the base of the microscope. To change the fuse you have to put the microscope on the back and you have to open the base plate carefully with a slotted bolt turner.

The defect fuse is to be replaced with a new fuse (delay fuse 100mA for 115V to 230V).

After that the base plate can be closed and saved with a screw again and the microscope can be set up.

### 3.2. Care of components

**3.2.1.** The dioptre rings are unscrewed, those threads easily greased and by repeated and movement of the dioptre rings it is all greased evenly. When mounting the rings, ensure that their marks agree with the index lines on the eyepiece connecting piece.


**3.2.2.** *Eyepieces, tube and interchangeable objectives* should be cleaned regularly with a soft hair brush. In addition these parts should be removed from the equipment and all accessible optical parts should be carefully cleaned. Each attempt to disassemble the objective will cause a complete adjustment error of the objective. Optics and lenses can be cleaned by a cleaning tissue for optics. Medical alcohol is recommend as cleaner.

**3.2.3.** In case the *microscope* isn't in use you should cover the microscope with the delivered protective cover.

**3.2.4.** We recommend to use antifriction bearing grease of middle consistency for lubricating the slide faces of the sliding stage. Lightly lubricate both faces in regular time intervals with this grease. Before doing this, carefully remove the old grease with a grease dissolver.

## 4. Supplementary Equipment

### 4.1. Eyepieces

**4.1.1.** *Fixed eyepieces* are available for different magnifications (first number) and with different field of view numbers (second number). With its assistance the total magnification can be changed beyond the range of the magnification changer, without the work distance is affected. All eyepieces are equipable with eyecups. All eyepieces GF – Pw 10x/20 and GF · P 16x/12,5 are usable as eyeglass (spectacles) wearer eyepieces (eyeglass symbol, ).

**4.1.2.** *Adjustable eyepieces* will be offered for simple measurements or for counting and can be fitted with various reticles.

The fixed eyepiece will be removed and the adjustable eyepiece will be inserted. By setting the eye lens the adjustable eyepiece will be focused on the reticle.

### 4.2. Tubes

**4.2.1.** The *monocular straight tube* is a tube, which is used mainly as the second perpendicular observation view in connection with a binocular straight tube and a Phototube



*pic. 7: monocular straight tube*

**4.2.2.** The polarized light able *binocular straight tube* requires the use of two oculars of the same enlargement [a fixed ocular for the left adjustable tube pipe and an adjustable ocular] for the right fixed tube pipe.

The sharpness adjustment can be done with the adjustable eyepiece for the right side and with the dioptre ring for the left side.



*pic. 8: binocular straight tube*

The standard equipment of the binocular straight tube is prepared for eyepieces with a plug-in diameter of 30 mm. A special equipment is prepared for eyepieces with a plug-in diameter of 23,2 mm, or 23,2 mm eyepieces can also be used in case with a special adapter.

### 4.3. Objectives

There are different kind of objectives, e.g. M-Plan  $\infty$  or achromatic objectives in different magnifications (5x ; 10x ; 20x ; 50x)



*pic. 9: objectives*

### 4.4. Colour filter

A blue matted glass with a diameter = 32 mm can be done into a filter holder, so that the light becomes daylight similar (if halogen light illumination is in use). In order to change generally the colour of the lighting, colour filters are used, which are in a similar holder like the blue matted glass.

## 5. Intermediate Tubes

### 5.1. Angled tube

The angled tube is used in connection with the straight binocular tube. The tube is equipped with a 30° angle and image erection (IE). It is attached between the centre section of the microscope and the straight binocular tube. (for 160mm Objectives)



*pic. 10: angled tube 30° with IE*

### 5.2. Photo-/TV tube

If binocular observation and photographic or video-technical recording should take place simultaneously, you can use the photo tube. The tube is equipped with a 30° angle and image erection (IE). The photo tube is set on the centre part of the microscope and has connections for the straight binocular tube and a photo or TV adapter.



*pic. 11: photo tube 30° with IE*

Beyond that a further Photo-/TV tube with a firm division ratio of 80/20 are available, i.e. 80% of the light are used for visual observation and 20% for the photographic reproduction or the video image. (for 160mm Objectives)



### 5.3 Wide Field Photo Tube for M-Plan Objectives

The trinocular phototube 50/50 with image erection is especially suited for visual observation as well as photo and TV documentation at the same time. For an optimal view the visual optical path is equipped with a 30° angle.

The photo exit with a 0,8x magnification factor means an according field of view adjustment for a efficient pixel saturation and a wide unvignetted image field.



*pic. 12: wide field photo tube  $\approx 1x/0,8x$*

## 6. Measuring instruments

### 6.1. Eyepiece measuring plate

The eyepiece measuring plates are provided and a measuring scale is inserted into a adjustable eyepiece. The eyepiece - cross-line divides the field of view into 4 quadrants and marks the field of views centre. To use the eyepiece measuring plates the eyepiece - line disk version is unscrewed, and the line plate is inserted in such a way into these that the engraving points downward to the object. When connecting, the screen is again screwed in.

### 6.2. Object measuring plate

The Object measuring plate serves for the calibration of the measuring software for normal and as well as for microscopic linear measurements. The division is on the top side of the plate. For calibrating, the division is turned to the objective. For direct linear measurement of even objects these are placed on the object measuring plate with the division downward on the object surface.

The object - surface plate 70/0.5 10/0.1 2/0.01 orders a calibration of 0.5mm and in the centre a division length of 10 mm with a calibration of 0.1 mm on a division length of 70mm. Moreover it orders a division of 2.0mm with a calibration of 0.01mm additionally in the centre of this division.

### 6.3. Measuring software

Objects can be captured with a video- or photo camera which is mounted directly on a microscope. These captured objects can be stored in digital form. After a calibration of the whole microscope system (with help of a measuring plate) it is possible to measure this objects.

Several measuring programs are available. For the use of these programs it is necessary to equip a computer with digital camera like a digital USB camera or a digital D-SLR camera to the microscope (over the Photo-/TV tube).

The measuring programs will be describe separately in the manual of the manufacturer of the software (the manual is not part of this manual).

7. Documentation

7.1. Photography over Photo-/TV tube

If visual observation and photographic photographs without changes are to be made, then the use of the Photo-/TV tube offers itself. A photo adjustment and the type of camera appropriate T2 – adapter is needed. There are different photo adjustments available: 1x ; 1,6x and 3,2x.

It is better to insert into the adjustable eyepiece a cross-line plate to see which part of the object (picture) will be shown on the film and to suppress the individual accommodation.

The Photo-/TV tube is mounted on the intermediate tube and the photo adjustment on the upper exit of the Photo-/TV tube itself. The objective is removed from the camera and the T2-adapter will be mounted there. The photo adjustment cannot be adjusted, because it is so balanced that after the normal alignment of the microscope also the picture appears sharp on the film level.

7.2 Digital photography

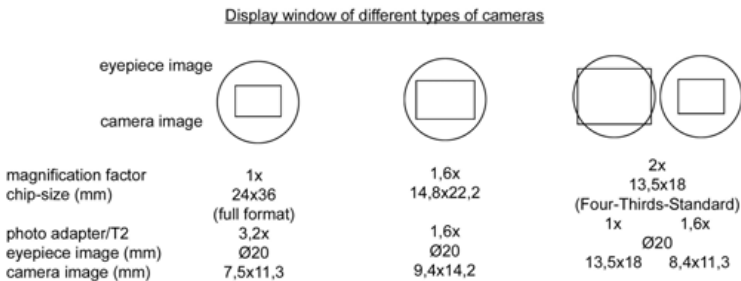
The connection of digital single lens reflex cameras is done by a sensor fitted photo adaptation and camera suited T2 adaptation ring. Three different photo adaptation 1,0x; 1,6x; 3,2x are available.

For a maximum object field following optimal combinations between sensor size and photo adaptation are recommended:

Full frame	24,0mm x 36,0 mm	→ 3,2x
APS-C	14,8mm x 22,2mm	→ 1,6x
Four Thirds	13,5mm x 18,0mm	→ 1,0x



pic. 13: photo adaptations 3,2x; 1,6x; 1,0x



## 8. TV – Transfer

### 8.1. TV – Transfer over Photo-/TV tube

For the TV transfer is only a Photo-/TV tube and a TV with camera and a monitor adjustment are needed. For the right adaptation of the image detail of the camera in comparison to the image in the eyepiece there are four different TV-adapters available with magnification factor 0,3x ; 0,4x ; 0,4xWF ; 0,63x ; 1x and 1,6x.

The Photo-/TV tube is set for adjustment on the microscope centre section. At the upper exit of the Photo-/TV tube will be mount the TV adapter and above the TV adapter will be set a video camera (in most cases the thread is c-mount)

All TV-adapters will be aligned factory-made at the delivery. In normal case you don't have to change nothing. In case you don't have a clear picture you have to follow the instructions at points 8.1.1 and 8.1.2.

**8.1.1** The *TV-adapter 1x* comes in two parts which will be clamped with two screws. The lower part will be set directly on the Photo-/TV tube, the upper part will be set on the T2-adapter. Both parts will be add together and will be adjust against each other at a good aligned microscope with smallest magnification factor until there is a clear and sharpen picture on the monitor. Now you have to align the camera itself (left and right side of a picture) and the screws will be tighten.



*pic. 14: Tv – adaptation 0,3x ... 1,6x*



*pic. 15: phototube with Tv adaptation 0,63x and camera*

**8.1.2** You have to do the same steps for the TV-adapter 0,3x ; 0,4x ; 0,4x WF ; 0,63x and 1,6x (analogous in comparison to the TV-adapter 1x)

## 9. Illumination

### 9.1. 3W – LED Transmitted light

For a research of transmitted objects it can be helpful to observe the objects not only in incident light illumination. The use of transmitted light illumination is good to define structures much more better.



*pic.16: stage carrier with object guide and condenser for transmitted light*

Please note: The 3W-LED transmitted light can be only used in combination with stage carrier with object guide.



*pic.17: optics for transmitted light (placed in the stand)*

Further it is necessary to use a condenser. The condenser comes with a wide field lens and an aperture stop.

### 9.2. Oblique incident light (dark field)

For a lot of objects dark field will most suited – contours have a high contrast; finest structures, reliefs, damages on surfaces are much more better visible than with bright field illumination.

The equipment comes with an articulated arm and a 3W-LED incident light illuminator, focusable and a transformer for the 3W-LED illumination, adjustable. This illumination is suited for the objectives 5x; 10x; 20x.



*pic.18: oblique incident light*

## 10. Stages

Gliding stage, stage carrier with object guide and stage carrier with rotary stage can be changed quickly without any problems about a changer.

### 10.1. Gliding stage

The gliding stage offers the possibility of a free positioning of the object within a diameter of 40 mm can be done with the precise gliding stage. The maximum height of the specimen is 30 mm.



*pic. 19: gliding stage*

### 10.2. Stage carrier with object guide

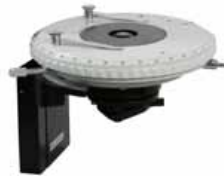
The object-guide allows a x-y- adjustment in range of 76 x 26 mm. The maximum height of the specimen is 40 mm.



*pic.20: stage carrier with object guide*

### 10.3. Stage carrier with rotary stage

The stage carrier with rotary stage is usable for the research of translucent polarizing objects. The stage allows the determination of axial attitudes from birefringent objects. The maximum height of the specimen is 35 mm.



*pic. 21: stage carrier with rotary stage*

### 10.4. Magnet spherical stage

The magnet spherical stage is suited for probe positioning and tilting the object to a max. 45° angle. The object clamp is done by small magnet mounts. To avoid slipping the spherical stage is also magnetic mounted.



*pic.22: magnet spherical stage*

## 10.5. Depth measurement

**10.5.1** Depth measurement (z-axis) with the *combination drive* is done by reading the scale on the drive knob during fine focussing between the two or more certain object levels. The scale is divided into 100 units. When the fine drive is used One graduation mark equals  $2,8\text{ }\mu\text{m}$ . The range of depth measurement with combination drive is  $0,288\text{ mm}$ .

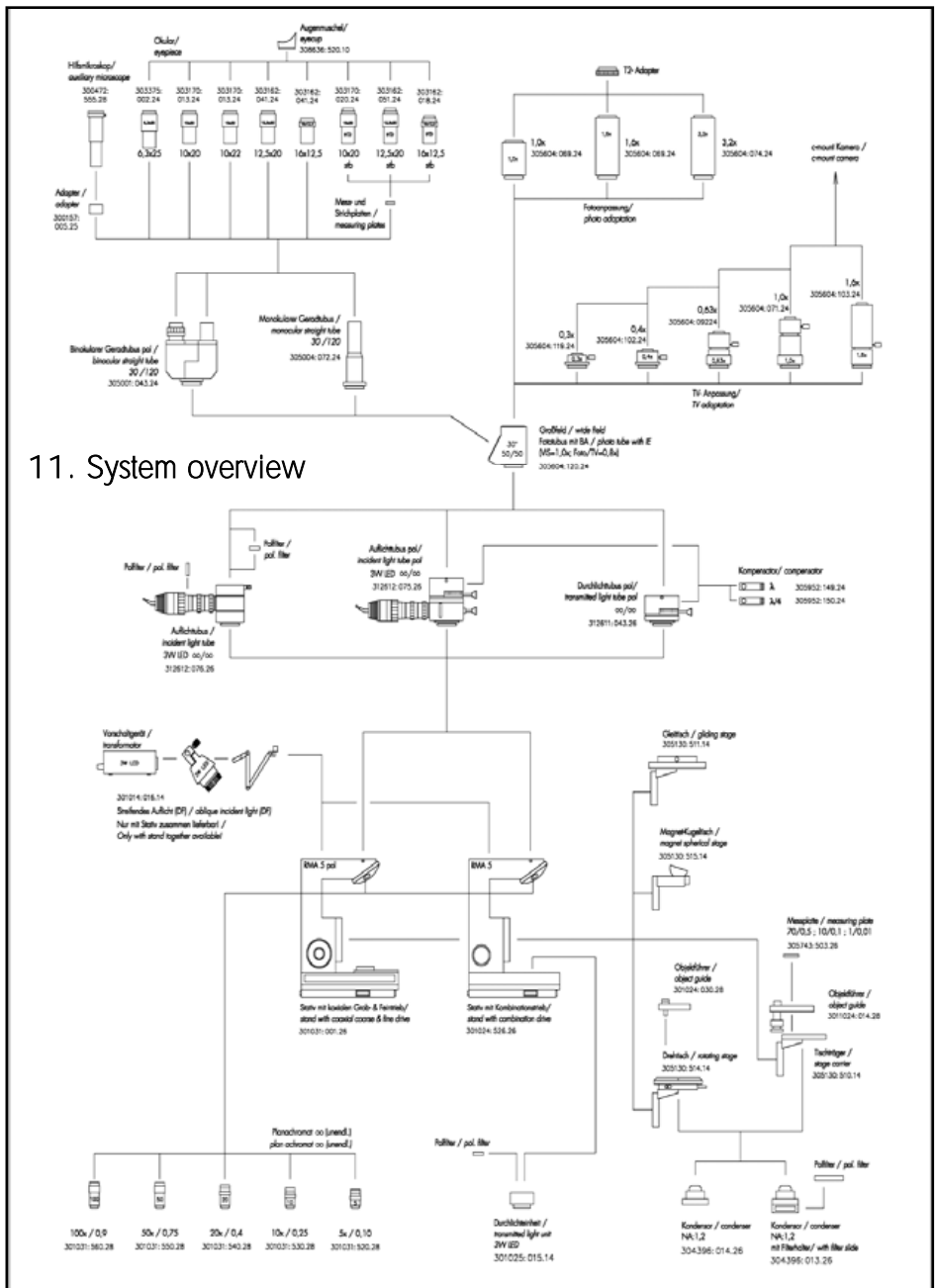
To avoid measuring errors caused by the reversal error of the drive (combination and coaxial coarse and fine drive) just measure the object points (object levels) from only one direction.

**10.5.2** Depth measurement with the *coaxial coarse and fine drive* is almost the same as with the combination drive. The scale is divided into 50 units. When the fine drive is used one graduation mark equals  $2,0\text{ }\mu\text{m}$ . The range of depth measurement with coaxial is limited to adjustable range of coarse drive ( $20\text{ mm}$ ).

**10.5.2** Depth measurement can also be done with help of a analogue or digital dial indicator gauge which is mounted on the side. The gauge sensor cone is connected to the stage.



*pic. 23: indicator gauge for depth measurement*



## 12. Complaints, Warranty

Obvious defects must be notified in writing without delay, but at the latest within one week of receipt of the goods, together with a declaration of what was found. Failure to inspect the goods counts as an unreserved acceptance of their compliance with the conditions. The warranty period is 2 years.

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